

D-Star via TEVEL satellites

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WD9EWK's Operating Equipment

When AO-27 was launched in 1993, nobody knew that it would eventually support digital voice communications. D-Star was developed by the JARL in the late 1990s, and Icom started manufacturing D-Star equipment a few years after that. Using D-Star via satellite was successfully demonstrated by Michael Wyrick N3UC and Robin Cutshaw AA4RC in July 2007 on AO-271. Remembering that AO-27 had been used for D-Star testing many years earlier, Endaf Buckley N6UTC/MW1BQO and I decided to try D-Star when AO-27 was brought back to life and active over the Northern Hemisphere in 2021. Despite its limited operating schedule, Endaf and I - and others - were able to make D-Star contacts through AO-272. I even wrote an article about using D-Star via AO-273. My last

D-Star contact via AO-27 was on New Year's Day in 2023, but a bigger surprise appeared a few months later.

Eight TEVEL satellites, built by 8 different high schools in Israel with support by the Herzliya Science Centre, were launched in 2022. These are identical CubeSat satellites with FM repeaters, sharing the same frequencies (145.970 MHz uplink, 436.400 MHz downlink). When the satellites were close to each other in orbit, that may have contributed to the issues in activating any of them. In December 2022, TEVEL-3 had its FM repeater activated for the first time. Then in May 2023, TEVEL-3's FM repeater was activated again, followed by the repeaters on TEVEL-4 and TEVEL-5. In the end, the command station

for the TEVEL satellites, David Greenberg 4X1DG, said that 6 of the 8 TEVEL satellites are operational. FM repeaters on TEVEL-1 and TEVEL-8 have yet to be activated. 4X1DG also mentioned that the FM repeaters can be activated for 72 hours at a time. Since early May, 4X1DG has been doing exactly that - activating 1 or 2 satellites on weekdays, 3 or 4 on weekends, and posting updates on the AMSAT-BB mailing list and his Twitter account⁴.

On 31 May 2023, I was working TEVEL-2 around 1730 UTC using my Icom ID-5100 2m/70cm mobile radio. This pass covered most of North America. Near the midpoint of the pass, I heard the downlink change. I didn't know what I was hearing. It sounded like it could have been 9600bps packet, like we had from FalconSat-3. Or it could have been something like D-Star. The transmissions were longer than a typical packet transmission heard through FalconSat-3. A couple of minutes later, when the pass wasn't as busy, I changed the ID-5100's VFOs from FM to D-Star. When I transmitted in D-Star, the ID-5100's sub VFO muted. This is normal for the ID-5100 when working D-Star via satellite, as this radio is not capable of full-duplex operation using D-Star. The fact the sub VFO muted while I transmitted confirmed that D-Star could be transmitted through TEVEL-2.

The next day, 1 June 2023, I used a two-radio setup for a morning TEVEL-2 pass: Icom ID-4100 2m/70cm mobile radio for the uplink, a Kenwood TH-D74 handheld radio for the downlink, with both radios connected through a 2m/70cm diplexer to my Elk handheld log periodic antenna. I worked most of the pass in



WD9EWK receiving N6UTC via TEVEL4 DStar

FM, then late in the pass I switched my ID-4100 to D-Star. I identified my station, and heard that through TEVEL-2 on the TH-D74 in D-Star. After this successful test, I mentioned this to N6UTC, and we planned to try working TEVEL passes with radios capable of D-Star.

For the testing with N6UTC on 3 June 2023, I used a different full-duplex D-Star setup. I transmitted from an Icom ID-5100 with 145.970 MHz in each VFO (one in FM, and the other in D-Star). For the downlink, I used my ID-4100 configured to receive both FM and D-Star like I previously did with AO-27. N6UTC had his Icom ID-880H. We were able to work each other in FM and D-Star, and I posted videos showing these contacts⁵. Then I sent David Greenberg 4X1DG a report on how well the TEVEL satellites have been working, including details on the D-Star testing.

Since those tests in early June 2023, N6UTC and I have made D-Star contacts on all 6 of the available TEVEL satellites. A few others have tried D-Star through these satellites, and I have been able to work two other stations (WC7V in Montana with an IC-9100, KC7JPC in Washington state with either an IC-2820H or two IC-705s) along with N6UTC. On some evenings, there have been quick roundtable chats - N6UTC, KC7JPC, and me - using D-Star. We have to be quick, paying attention to the downlink in case FM traffic is heard. When a station appears in FM, we can quickly change the uplink mode on our radios to FM and make contacts with the other stations.

There are settings in the Icom and Kenwood D-Star radios that help the D-Star operators monitor FM traffic on the TEVEL satellite passes. Most Icom D-Star radios have a menu setting "DV Auto Detect", which is normally set to "OFF". Changing this setting to "ON" allows

reception of both FM and D-Star signals when the VFO is set to D-Star (DV). The Kenwood TH-D74 has a similar menu setting, "FM Auto Det. on DV", in menu item 617. Newer radios appear to do a better job at receiving FM with "DV Auto Detect" enabled. Having "DV Auto Detect" enabled is highly recommended.

Many Icom D-Star radios also have another setting, "Digital Monitor", which is normally set to "Auto" instead of either "Analog" or "Digital". Using the default "Auto" setting is also highly recommended for those using D-Star on the TEVEL satellites.

Just like using D-Star through terrestrial repeaters, your call sign is transmitted to anyone hearing the TEVEL satellite downlink in D-Star. Additional data like a message or your location can also be transmitted, just like with a terrestrial D-Star repeater or hotspot. From my experience with AO-27 and the TEVELs, the additional data sent with a D-Star signal doesn't appear to handle Doppler as well as the digital voice. When it works, the station's call sign - along with additional data like a short message, or the station's location - will appear on the displays of other stations monitoring the pass.

To transmit your location along with your digital voice transmissions using D-Star, I recommend using the NMEA format, also known as "GPS (DV-G)" for older Icom radios. Icom's D-PRS format, also known as "GPS-A (DV-A)" for some Icom D-Star radios, isn't supported by the older Icom D-Star radios or the Kenwood TH-D74. When NMEA is selected, I use the GGA sentence (the default for the NMEA format in many Icom D-Star radios) for the GPS data.

As for how to work TEVEL satellite passes using D-Star, full-duplex operation is always the best way to go. Unfortunately, only the IC-9700 is capable of working satellites full-

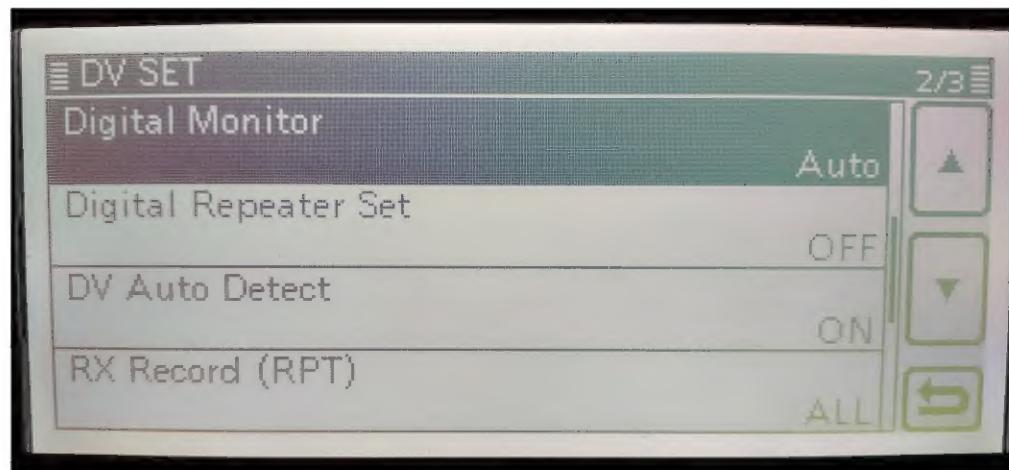


N6UTC receiving KC7JPC and WD9EWK on ID880H via TEVEL DStar

duplex using D-Star with a single transceiver. Other Icom radios supporting full-duplex operations via FM satellites - the ID-5100, the IC-2820H/IC-E2820 with optional UT-123 D-Star module, and the IC-9100 with optional UT-121 D-Star module - are not capable of full-duplex operations using D-Star. In particular, the ID-5100's sub VFO mutes if it receives a D-Star signal while transmitting from the main VFO. Only the IC-9700 has two vocoders for D-Star, one for each VFO. Whether using one IC-9700 or two radios, there is a slight delay receiving D-Star signals, due to the radio having to decode the audio from the digital transmission. Other than that, using D-Star via satellite is a lot like using FM via satellite.

D-Star capable radios not capable of full-duplex operation can be used with the TEVEL satellites. For this, I operate half-duplex using the VFO and two memory channels. The two memory channels have the same 145.970 MHz uplink frequency, but different modes - FM in one, D-Star (DV) in the other. The VFO should be in DV mode, with the "DV Auto Detect" menu setting enabled. Then the VFO/MR button on the radio or microphone can be used to switch from the downlink to the uplink before transmitting, and back to the downlink after a transmission. The memory channels and VFO frequency can be changed using the tuning knob on the radio, or the up/down buttons on the microphones.

Anyone planning to use D-Star on TEVEL satellites should be ready to stand by when passes are full of FM traffic, or join in the activity using FM. The operators using FM will hear a different sort of noise when D-Star transmissions are being heard on the downlink⁶, and may



ID-5100 Digital Monitor and DV Auto Detect settings

not realize that noise isn't just static. When the passes are quiet(er), it is nice to make quick contacts using D-Star. I have examples of passes on the TEVEL satellites where D-Star was used to make contacts on my YouTube channel⁷.

Many thanks to Endaf Buckley N6UTC/MW1BQO and John Colville KC7JPC for their assistance in writing this article, and for being on many TEVEL satellite passes where we worked each other using D-Star and FM, trying different radios or combinations of radios on the passes.

Footnotes:

1. <http://web.archive.org/web/20120108002519/http://www.ao27.org/AO27/index.shtml>
2. Videos of N6UTC-WD9EWK D-Star QSO via AO-27 on 13 March 2021: <https://youtu.be/ZGOJUF4gl24> and <https://youtu.be/CROzBpwtAeU>
3. "D-Star via AO-27." OSCAR NEWS, issue 235 (September 2021): pp. 12-15
4. <https://twitter.com/DavidGr06270644>
5. <https://youtu.be/FkPSkR0aqwc> and <https://youtu.be/7UmVj2equCE>
6. <https://youtu.be/u82PMseJogE>
7. <https://www.youtube.com/va7ewk>